Shallow seismic structure of Onikobe geyser, Miyagi Prefecture based on the analyses of active seismic experiment data

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Onikobe geyser, which is located in the southern part of Onikobe caldera, Miyagi Prefecture, effuses hot water every about 10 minutes at height of 6-8 m. At the geyser, hot water is constantly supplied to the reservoir system and effusions occur due to the de-pressurization and boiling mechanism. The fluid under the ground may cause some changes in the amplitude of seismic wave propagating through the system. In this study, therefore we analyze the data of active seismic experiment in order to understand the shallow structure at the geyser. The active seismic experiment was conducted in June 2007 and we deployed 15 vertical component seismometers of Mark Products (2 Hz) every about 5 m in the area of 28 m x 16 m around the geyser's vent. We configured 13 shots in order to reach optimum seismic ray coverage across the geyser. We excited seismic waves at each location using a drop hitter of weight about 50 kg. The data were recorded at a sampling frequency of 1 kHz with an A/D resolution of 16-bit. The result of travel time analysis indicates that shallow structure consists of two horizontal layers having P-wave velocity of 625 m/s and 3300 m/s. The thickness of the first layer is estimated to be 3.8 m. Filtering the data at a frequency band of 160-320 Hz, we read amplitudes of the first oscillation of the P-waves having wavelength of about 3 m. Since the observed spatial changes of P-wave amplitude can not be explained only by geometrical spreading, we apply an inversion method to the observed data to quantitatively evaluate the P-wave attenuation structure in the shallow portion. Approximating the wave field by the far field term and attenuation quality factor, we solve spatial changes of Q^{-1}, site factors and source strengths using a nonnegative least square method with 2D spatial smoothing. High attenuation structure Q^{-1} (larger than 0.020 and less than 0.070) is recognized around the eastern part of the vent. The regions having high attenuation seem to be extended to the southern part of the vent. However, such high attenuation structure regions do not surround the geyser as the regions behind the vent show low attenuation structure. High attenuation region in the eastern region of the vent is almost the same with the location of self potential anomaly, which may represent by advection or migration of water under the ground, obtained by Mishima et al. (2007). These observations strongly suggest that the path of hot water under the ground is the origin of high attenuation region at Onikobe geyser.